

A STUDY ON AUTOMATIC DUAL AXIS SOLAR TRACKER SYSTEM USING 555 TIMER

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Abstract—This automatic dual axis solar tracker system is a design and implementation of a polar single axis solar panel tracker. It has a fixed vertical axis and an adjustable horizontal motor controlled axis. This setup is similar to an office swivel chair. The tracker actively track the sun and change its position accordingly to maximize the energy output. To prevent wasting power by running the motor continuously, the tracker corrects it's position after 2 to 3 degrees of misalignment. The sensors compare the light intensities of each side and move the panels until the tracker detects equal light on both sides. Additionally, it prevents rapid changes in direction that might be caused by reflections, such as cars passing by. A rear sensor circuit is also incorporated to aid in repositioning the solar panels for the next sunrise. The gear motor has overturn triggers to prevent the panel from rotating 360° and entangling wires. The motor control and sensing circuitry runs on batteries charged by the solar panel. This system uses three small 10W solar panels of approximately 15 inches by 10 inches to model larger panels used in industry.

Index Terms— solar tracker, solar panel, solar energy, sensors etc. (*key words*)

I. INTRODUCTION.

A solar tracker is a device for orienting a solar photovoltaic panel, day lighting reflector or concentrating solar reflector or lens toward the sun. Solar power generation works best when pointed directly at the sun, so a solar tracker can increase the effectiveness of such equipment over any fixed position. The solar panels must be perpendicular to the sun's rays for maximum energy generation. Deviating from this optimum angle will decrease the efficiency of energy generation from the panels.

A few degrees of misalignment will only cause 1% to 5% of energy loss, while larger angles of 10° to 20° will significantly decrease the energy generation of up to 35%. Although, this loss is also dependent on the material and pattern of the protective glass that covers the solar panel. An active tracker uses motors to direct the panel toward the sun by relying on a sensing circuit to detect light intensity.

There are two main ways to mount a solar panel for tracking; single axis and dual axis. Single axis trackers usually use a polar mount for maximum solar efficiency. Polar trackers have one axis aligned to be roughly parallel to the axis of rotation of the earth around the north and south poles. When compared to a fixed mount, a single axis tracker increases the output by approximately 30%

The second way is a two axis mount where one axis is a vertical pivot and the second axis is the horizontal. By using a combination of the two axes, the panel can always be pointed directly at the sun. This method increases the output by approximately 36% compared to stationary panels.

II. MOTIVATION

Commercial made solar trackers are a nice addition to any solar panel array. They help increase the time that panels directly face the sun and allow them to produce their maximum power. Unfortunately they can be expensive to buy. To reduce its cost solar tracking can be done using time instead of using a device that would sense where the sun is and move the panels toward it.

The objective of this system is to control the position of a solar panel in accordance with the motion of sun.

Brief Methodology: This system is designed with solar panels, LDR'S, 555 Timer, Stepper Motor and its driving circuit.

III. PROBLEM STATEMENT AND OBJECTIVE

Renewable energy is rapidly gaining importance as an energy resource as fossil fuel prices fluctuate. At the educational level, it is therefore critical for engineering and technology students to have an understanding and appreciation of the technologies associated with renewable energy.

One of the most popular renewable energy sources is solar energy. Many researches were conducted to develop some methods to increase the efficiency of Photo Voltaic systems (solar panels). One such method is to employ a solar panel tracking system. This system deals with a RTC based solar panel tracking system. Solar tracking enables more energy to be generated because the solar panel is always able to maintain a perpendicular profile to the sun's rays. Development of solar panel tracking systems has been ongoing for several years now. As the sun moves across the sky during the day, it is

advantageous to have the solar panels track the location of the sun, such that the panels are always perpendicular to the solar energy radiated by the sun. This will tend to maximize the amount of power absorbed by PV systems.

It has been estimated that the use of a tracking system, over a fixed system, can increase the power output by 30% - 60%. The increase is significant enough to make tracking a viable proposition despite of the enhancement in system cost. It is possible to align the tracking heliostat normal to sun using electronic control by a micro controller. Design requirements are:

1) During the time that the sun is up, the system must follow the sun's position in the sky.

2) This must be done with an active control, timed movements are useful. It should be totally automatic and simple to operate.

The operator interference should be minimal and restricted to only when it is actually required. The major components of this system are as follows.

- 1) 555 TIMER
- 2) LDR'S
- 3) Output mechanical transducer (stepper motor).
- 4) Decade counter CD4017
- 5) Photovoltaic cells

IV. BACKGROUND

The purpose of solar panels is to meet the growing demand for renewable energy resources. In the modern world, the demand for electricity has grown at alarming rates to meet the needs of society. Many other benefits to solar energy include the lack of pollution directly created by these systems and their inexpensive and practical nature in the long term. As the demand for solar panels grow, so will the need for ways to optimize their energy collection. Tracking systems are designed to orient solar panels toward the sun. By adding a tracking system, the energy a solar panel can output could be increased by up to 50% during the summer months. This project is very practical and feasible as there are many types solar tracker designs in industry today. In addition, a similar senior project was done in 1994 on the "Sun Luis solar racer 101" electric car by a physics major, David Babbitt. However, the 1994 project dealt with manual panel adjustments given sensor data.

V. PREVIOUS WORKS

Wattsun

Array Technologies manufactures Azimuth Trackers for medium-to-large residential PV systems. Our Azimuth Tracker gear drive rotates the PV array on the pole mount so the bottom edge of the array always remains parallel to the ground. The result: a low profile and exceptional stability in the wind. A Dual-Axis Tracker enables automatic tracking of the sun's elevation as well. Dual-axis trackers completely capture all the power the sun delivers.

- AZ-225 Azimuth Gear Drive
- Dual-Axis Included
- Mounts up to 3500 Watts
- Up to 225 Sq. Ft. of PV array



Fig.1 wattsun

Wattsun active trackers are environmentally-friendly and are guided by a patented, optical, sun-sensing device that dramatically outperforms passive tracking systems. Solid state electronic design and positive drive mechanisms insure consistent operation in extreme temperatures and windy conditions.

SunTracer

SunTracer has a dual axis solar tracker. It can have an elevation angle from 15-90 degree. It makes use of the linear motor SM4S900M3 with stroke of 900mm. The tracking accuracy is less than 0.5 degrees and makes use of the protocol TdAPS (Time derived Astronomical Positioning System). It is possible to connect to a PC through USB. It can operate in temperature from -25C to 75C and withstand wind speeds from 130km/h.



Fig.2 sun tracer

SunTura

The main tracker mount holds two linear actuators and this is what moves the solar panels throughout the day. The main tracker mount is constructed from 6061 aluminum and stainless steel fasteners. The linear actuators are each rated to move 225 pounds of weight and each linear actuator can hold up to 450 pounds of static weight. One water-tight, epoxy sealed electronic sun tracker board ("the brain") is used for the controls. The brain is a solid state electronic control board which utilizes their proprietary software to track the sun with sub-degree accuracy and precision. The brain also has three manual switches mounted on it. Two of the switches allow you to manually move the tracker north/south/east/west and the third switch turns the tracker on/off. Manual maneuvering of a tracker is very convenient when you want to access the solar panels for cleaning or to position the solar panels parallel to the ground during extremely high winds. Four photo sensor mounts onto your tracking system. The four photo-sensors collect light from the sun and the brain uses this information to move the two linear actuators to track the sun.



Fig.3 SunTura

Solaria

Structurally certified to withstand wind loads of 90mph (145 km/h) in all directions with an autonomous controller. Only one controller required for every 750kW for greater reliability. This is only a single axis Azimuth tracker which makes use of a double worm gear unit with a 3 phase AC motor. The controller is PLC-based that monitor

position.



Fig.4 Solaria

VI. LITERATURE SURVEY

A. Technology of Solar Panel

Solar panels are devices that convert light into electricity. They are called solar after the sun or "Sol" because the sun is the most powerful source of the light available for use. They are sometimes called photovoltaic which means "light-electricity". Solar cells or PV cells rely on the photovoltaic effect to absorb the energy of the sun and cause current to flow between two oppositely charge layers.

A solar panel is a collection of solar cells. Although each solar cell provides a relatively small amount of power, many solar cells spread over a large area can provide enough power to be useful. To get the most power, solar panels have to be pointed directly at the Sun.

The development of solar cell technology begins with 1839 research of French physicist Antoine-Cesar Becquerel. He observed the photovoltaic effect while experimenting with a solid electrode in an electrolyte solution. After that he saw a voltage developed when light fell upon the electrode. According to Encyclopedia Britannica the first genuine for solar panel was built around 1883 by Charles Fritts. He used junctions formed by coating selenium (a semiconductor) with an extremely thin layer of gold.

Crystalline silicon and gallium arsenide are typical choices of materials for solar panels. Gallium arsenide crystals are grown especially for photovoltaic use, but silicon crystals are available in less-expensive standard ingots, which are produced mainly for consumption in the microelectronics industry.

Norway's Renewable Energy Corporation (REC) has confirmed that it will build a solar manufacturing plant in Singapore by 2010 - the largest in the world. This plant will be able to produce products that can generate up to 1.5 gigawatts (GW) of energy every year. That is enough to power several

million households at any one time. Last year, the world as a whole produced products that could generate just 2 GW in total.

Hasan A.Yousuf had given the design and implementation of a fuzzy logic computer controlled sun tracking system to enhance the power output of photo-voltaic (PV) solar panels in 1999.

F.Hung et al. had designed a microcontroller based automatic sun tracker combined with a new solar energy conversion unit in 1998.it was implemented with a dc motor and a dc motor controller. The solar energy conversion unit consisted of an array of solar panels, a step up chopper, a single phase inverter, an ac mains power source and a microcontroller based control unit.

B. Evolution of Solar Tracker

Since the sun moves across the sky throughout the day, in order to receive the best angle of exposure to sunlight for collection energy. A tracking mechanism is often incorporated into the solar arrays to keep the array pointed towards the sun.

A solar tracker is a device onto which solar panels are fitted which tracks the motion of the sun across the sky ensuring that the maximum amount of sunlight strikes the panels throughout the day. When compare to the price of the PV solar panels, the cost of a solar tracker is relatively low.

Most photovoltaic (PV) solar panels are fitted in a fixed location- for example on the sloping roof of a house, or on framework fixed to the ground. Since the sun moves across the sky though the day, this is far from an ideal solution.

Solar panels are usually set up to be in full direct sunshine at the middle of the day facing South in the Northern Hemisphere, or North in the Southern Hemisphere. Therefore morning and evening sunlight hits the panels at an acute angle reducing the total amount of electricity which can be generated each day.

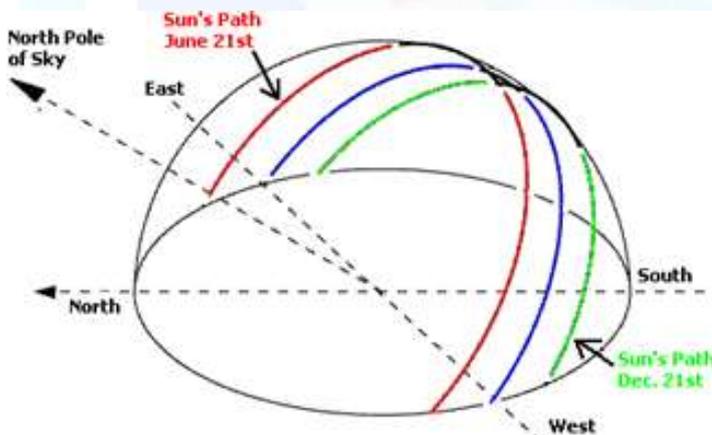


Fig 5: Sun's apparent motion

During the day the sun appears to move across the sky from left to right and up and down above the horizon from sunrise to

noon to sunset. Figure 1 shows the schematic above of the Sun's apparent motion as seen from the Northern Hemisphere.

To keep up with other green energies, the solar cell market has to be as efficient as possible in order not to lose market shares on the global energy marketplace. There are two main ways to make the solar cells more efficient, one is to develop the solar cell material and make the panels even more efficient and another way is to optimize the output by installing the solar panels on a tracking base that follows the sun.

The end-user will prefer the tracking solution rather than a fixed ground system to increase their earnings because:

- The efficiency increases by 30-40%
- The space requirement for a solar park is reduced, and they keep the same output
- The return of the investment timeline is reduced
- The tracking system amortizes itself within 4 years (on average)

In terms of cost per Watt of the completed solar system, it is usually cheaper (for all but the smallest solar installations) to use a solar tracker and less solar panels where space and planning permit.

VII. APPLICATIONS OF SOLAR ENERGY

- Architecture and urban planning
- Agriculture and horticulture
- Solar lightning-street lightning
- Solar thermal energy
- Solar water heater systems
- Heating, cooling and ventilation
- Water treatment
- Solar cooker
- Solar electricity
- Solar vehicles
- Solar water treatment

VIII. ADVANTAGES OF SOLAR ENERGY

1. **No green house gases:-** The major benefit of solar is avoiding green house gases that fossil fuels produce. The first and foremost advantage of solar energy is that it does not emit any green house gases. Solar energy is produced by conducting the sun's radiation – a process void of any smoke, gas, or other chemical by-product. This is the main driving force behind all green energy technology, as nations attempt to meet climate change obligations in curbing emissions.

Italy's Montalto di Castro solar park is a good example of solar's contribution to curbing emissions. It avoids 20,000 tons per year of carbon emissions compared to fossil fuel energy production.

2. **Infinite Free Energy:-** Another advantage of using solar energy is that beyond initial installation and maintenance, solar energy is one hundred percent free. Solar doesn't require expensive and ongoing raw materials like oil or coal, and

requires significantly lower operational labor than conventional power production. Lower costs are direct as well as indirect – less staff working at the power plant as the sun and the solar semi conductors do all the work, as well as no raw materials that have to be extracted, refined, and transported to the power plant.

3. **Renewable Source:** Solar energy is a renewable source of energy and will continue to produce electricity as long as sun exists. Although solar energy cannot be produce during night and cloudy days but it can be used again and again during day time. Solar energy from sun is consistent and constant power source and can be used to harness power in remote locations.

4. **Low maintenance:** Solar cells generally don't require any maintenance and run for long time. More solar panels can be added from time to time when needed. Although, solar panels have initial cost but there are no recurring costs. Initial cost that is incurred once can be recovered in the long run. Apart from this, solar panel does not create any noise and does not release offensive smell.

5. **Easy Installation:** Solar panels are easy to install and does not require any wires, cords or power sources. Unlike wind and geothermal power stations which require them to be tied with drilling machines, solar panels does not require them and can be installed on the rooftops which means no new space is needed and each home or business user can generate their own electricity. Moreover, they can be installed in distributed fashion which means no large scale installations are needed.

6. **Solar's avoidance of politics and price volatility**

One of the biggest advantages of solar energy is the ability to avoid the politics and price volatility that is increasingly characterizing fossil fuel markets.

The sun is an unlimited commodity that can be adequately sourced from many locations, meaning solar avoids the price manipulations and politics that have more than doubled the price of many fossil fuels in the past decade.

7. **Solar jobs**

A particularly relevant and advantageous feature of solar energy production is that it creates jobs. The EIAA states that Europe's solar industry has created 100,000 jobs so far.

Solar jobs come in many forms, from manufacturing, installing, monitoring and maintaining solar panels, to research and design, development, cultural integration, and policy jobs.

IX. DISADVANTAGES OF SOLAR ENERGY

1. **Solar doesn't work at night**

Obviously the biggest disadvantages of solar energy production revolve around the fact that it's not constant. To produce solar electricity there must be sunlight. So energy must be stored or sourced elsewhere at night.

Beyond daily fluctuations, solar production decreases over winter months when there are less sunlight hours and sun radiation is less intense.

A very common criticism is that solar energy production is relatively inefficient.

Currently, widespread solar panel efficiency – how much of the sun's energy a solar panel can convert into electrical energy – is at around 22%. This means that a fairly vast amount of surface area is required to produce a lot of electricity.

However, efficiency has developed dramatically over the last five years, and solar panel efficiency should continue to rise steadily over the next five years.

2. **Storing Solar energy**

Solar electricity storage technology has not reached its potential yet.

While there are many solar drip feed batteries available, these are currently costly and bulky, and more appropriate to small scale home solar panels than large solar farms.

3. **Solar panels are bulky**

Solar panels are bulky. This is particularly true of the higher-efficiency, traditional silicon crystalline wafer solar modules. These are the large solar panels that are covered in glass.

New technology thin-film solar modules are much less bulky, and have recently been developed as applications such as solar roof tiles and "amorphous" flexible solar modules. The downfall is that thin-film is currently less efficient than crystalline wafer solar.

4. **One of the biggest disadvantages of solar energy – COST**

The main hindrance to solar energy going widespread is the cost of installing solar panels. Capital costs for installing a home solar system or building a solar farm are high.

Particularly obstructive is the fact that installing solar panels has large upfront costs – after which the energy trickles in for free. Imagine having to pay upfront today for your next 30 years worth of power. Currently a mega watt hour of solar energy costs well over double a mega watt hour of conventional electricity (exact costs vary dramatically depending on location).

X. AIM AND SCOPE OF THE SYSTEM

If we could configure a solar cell so that it faces the sun continually as it moves across the sky from east to west, we could get the most electrical energy possible. One way to do this, of course, is by hand. However, keeping a solar cell facing the sun throughout the day is not a very efficient use of a person's time.

Below are the main objectives of "ADASTS":-

- To design a system that can detect and compare the intensity of light
- To design a system that'd be able to move a motor based on the intensity of light
- To design a system that would be weather resistant

This system is designed to be fully functional outdoors and resist any complications. The main purpose of the system is to utilize the solar energy to its maximum and make the panel to rotate to the sun's maximum direction from morning to

evening automatically so that the panel grabs the solar energy to maximum extent throughout the day.

XI. TYPES OF SOLAR TRACKERS (BASED ON THE DESIGN OF PANEL)

There are many different types of solar tracker which can be grouped into single axis and double axis models:-

□ **Single axis trackers:-**single axis solar trackers can either have a horizontal or a vertical axle. The horizontal type is used in tropical regions where the sun gets very high at noon, but the days are short. The vertical type is used in high latitudes (such as in UK) where the sun does not get very high, but summer days can be very long.

These have a manually adjustable tilt angle of 0-45 degrees and automatic tracking of the sun from east to west. They use the PV modules to themselves as light sensor to avoid unnecessary tracking movement and for the reliability. At night the trackers take up a horizontal position.

This kind of tracker is most effective at equatorial latitudes where the sun is more or less overhead at noon. Due to the annual motion of the earth the sun also moves in the north and south direction depending on the season and due to this the efficiency of single-axis is reduced since the single-axis tracker only tracks the movement of sun from east to west. During cloudy days the efficiency of the single axis tracker is almost close to the fixed panel.

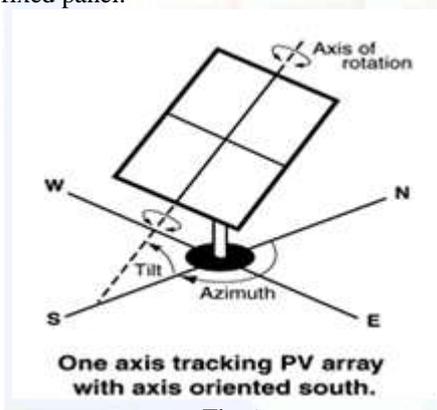


Fig 6

□ **Dual axis trackers:-** In dual-axis tracking system the sun rays are captured to the maximum by tracking the movement of the sun in four different directions. The dual-axis solar tracker follows the angular height position of the sun in the sky in addition to following the sun's east-west movement. Double axis trackers have both a horizontal and a vertical axle and so can track the sun's apparent motion exactly anywhere in the world. This type of system is used to control astronomical telescopes, and so there is plenty of software available to automatically predict and track the motion of sun across the sky. When the sun moves in the northern direction the tracker has to track the path of the sun in anti-clockwise direction along the horizontal axis (east to west). If the sun moves in the southern direction then the tracker has to track the path of the sun in clockwise

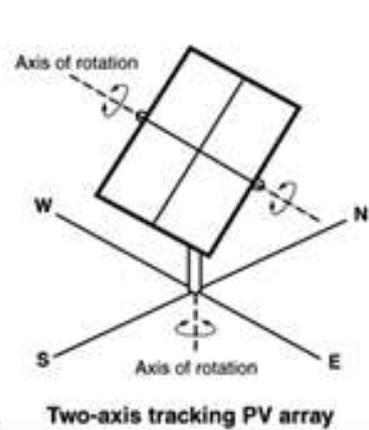


Fig 7

Dual axis solar trackers track the sun in both directions i.e. from east to west and north to south for added output power (approx 40% gain) and convenience.

Why not single axis tracker

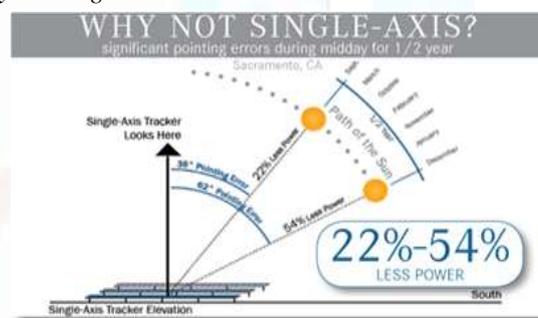


Fig.8

XII. TRACKER COMPONENTS

1. Sun tracking algorithm: This algorithm calculates the solar azimuth and zenith angles of the sun. These angles are then used to position the solar panel or reflector to point toward the sun. Some algorithms are purely mathematical based on astronomical references while others utilize real-time light-intensity readings.

2. Control unit: The control unit executes the sun tracking algorithm and coordinates the movement of the positioning system.

3. Positioning system: The positioning system moves the panel or reflector to face the sun at the optimum angles. Some positioning systems are electrical and some are hydraulic. Electrical

systems utilize encoders and variable frequency drives or linear actuators to monitor the current position of the panel and move to desired positions.

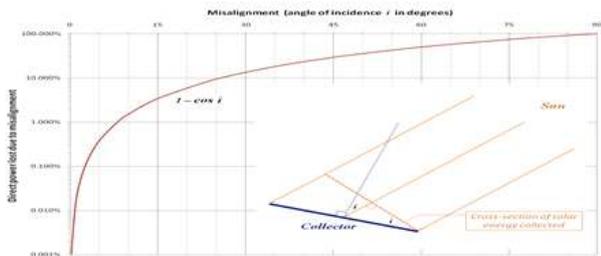


Fig. 9

The effective collection area of a flat-panel solar collector varies with the cosine of the misalignment of the panel with the Sun.

XIII. BLOCK DIAGRAM

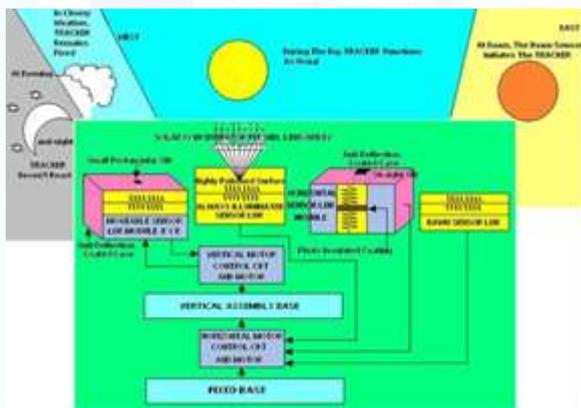


Fig.10

XIV. CIRCUIT DIAGRAM AND EXPLANATION

HORIZONTAL AXIS CIRCUIT:-

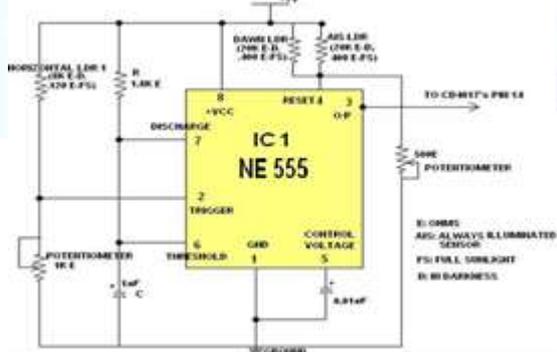


Fig.11

VERTICAL AXIS CIRCUIT

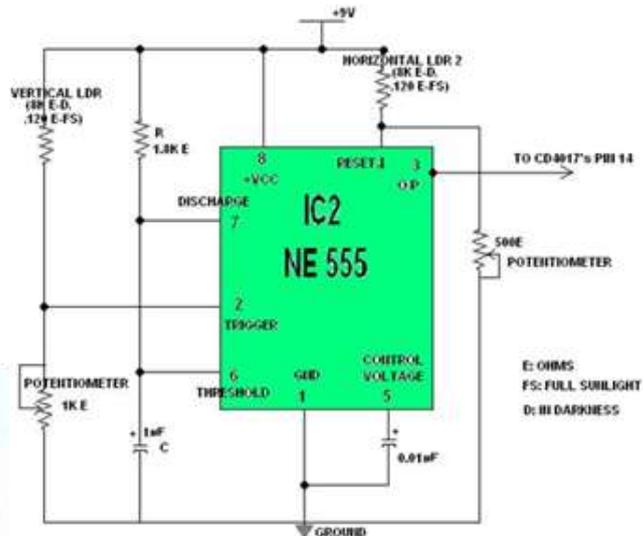


Fig.12

STEPPER MOTOR CIRCUIT

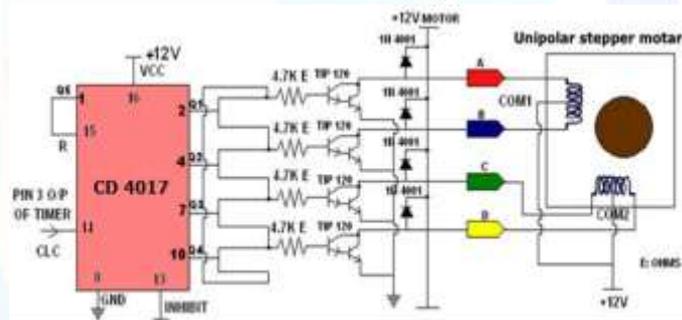


Fig.13

XV. EXPLANATION

There are three electronic modules to be explained. First one is the horizontal sensor module. It employs the timer 555 in the monostable mode. Pin 2(trigger Pin of 555) is hooked up with a voltage divider network (please see figure 6). Pin 4(reset) is hooked up with another voltage divider network. The LDR (say LDR A) which is always illuminated by light through Fresnel lens array has Low Resistance (in presence of light resistance of LDR decreases and vice-versa). We know $V(OUT)=V(IN)*[R(bottom)]/[R(bottom)+R(top)]$, where R stands For resistance. So in sunlight , when LDR A's resistance decreases voltage at pin 4 Increases. Timer is no more reset. PIN 2 is now lower than $1/3$ rd V_{cc} (as the horizontal LDR 1, say LDR B does not initially receive light through its rectangular slit, so its resistance is high($R_{top}=8$ K ohms), consequently $V(OUT)$ is low). This triggers the timer which gives a pulse to Decade Counter's Clock(14) PIN and triggers it. The Decade Counter CD 4017 gives a NORMAL STEP DRIVE pulse to the Horizontal Unipolar Stepper Motor

1(coupled to the tracker unit) to rotate the tracker position so as to receive sunlight(STEP ANGLE of 2 DEGREES). This goes on till the horizontal LDR 1 is fully in SUNLIGHT (resistance low, so PIN 2'S VOLTAGE HIGH). Thus the tracker has followed the SUN Horizontally.

We will come to the Vertical Sensor Module, but first let us see what the DAWN LDR (SAY LDR C) does. At night the horizontal Module timer 555 remains Reset (as LDR A is in darkness so its resistance is high, thus pin 4 voltage is low, and the TRACKER points at WEST (where SUN has set). Next day when SUN rises again in the EAST, the DAWN LDR which is located at the back of the TRACKER, points at EAST. So when it receives sunlight its Resistance goes low, thus Voltage at pin 4 is high and the timer triggers the Decade Counter which in turn switches the Motor on, thus the TRACKER again moves towards the EAST. Then the TRACKER functions as previously.

Now placed with the Horizontal Sensor LDR 1 is another similar LDR 2 which receives the sunlight as and when does LDR 1. SEE FIGURE 9. So now, as LDR B(THE 1st horizontal one) receives sunlight, so does Horizontal LDR 2(SEE FIGURE 6 figure 7), THESE LDRs are placed together with same alignment properties and separated by an optically insulated coating(from each other).Thus when Motor 1 comes to rest, and as the second horizontal LDR (SAY LDR D),is same way coupled to the second timer's(of Vertical Module) Reset pin as was the ALWAYS ILLUMINATED LDR A, it brings the second timer out of its Reset mode) by the previously discussed VOLTAGE RELATIONSHIP). EYE SENSOR LDR (SAY LDR E) of the tracker receives sunlight by an Anti-Reflection Coated, small Rectangular Slit, so reacts only when SUN directly points at it. The second 555's PIN 2 is same way connected to this LDR as was the first 555's to Horizontal LDR 1. So now that it still not receives sunlight (resistance high, so Vout low) and pin 4 is no more Reset, the second CD 4017 MAKES THE SECOND STEPPER MOTOR 2 Rotate (Coupled so as to only rotate VERTICAL SENSING BLOCK/EYE BLOCK). This movement continues till the SUN directly points at the EYE of our TRACKER. Then the TRACKER STOPS, pointing very accurately at the SUN.FIG 2 and FIG 3 follows. In figure 6 we have only shown the Horizontal Motor Control Circuit. The Vertical One uses a similar Decade Counter, NPN Transistors, Diodes (to encounter BACK EMF of Power Transistors due to Fast Switching). I chose for a Step Angle of 2 Degrees for the Unipolar Steppers. They are driven in a Normal 4 Step Sequence, first coil A is energized simultaneously with coil B, then coil C with coil D. Thus the Motors rotate by 2 degrees each time. The Charging Interval (how long pin 3 of 555's remains high) is almost in synchronism with the steps/second speed of the motors(here 600 steps/sec.), to avoid FALSE TRIGGERING.

NOTE:

1. For 555 in monostable mode, $T=1.1 \cdot R \cdot C$.

2. For the FRESNEL LENS ARRAY, the standard FL 40(Focal Length=0.4 inches) Or FL 65(Focal Length=0.65 inches) FRESNEL LENSES could be used (with the Grooves facing the LDRs).

3. For the ANTI-REFLECTION COATING, MULTI-LAYER COATING could be used to minimize loss due to REFLECTION. By using alternating layers of a Low-Index material like SILICA and a Higher-Index material, it is possible to obtain Reflectivities as low as 0.1% at Single Wavelength.

XVI. CONCLUSION

Renewable energy solutions are becoming increasingly popular. Photovoltaic or solar Systems are one good example of this. In order to maximize power output from the solar panels, one needs to keep the panels aligned with the sun. This is a far more cost effective solution than purchasing additional solar panels when dealing with large panel arrays.

A fairly large solar panel tracker would cost several hundred dollars and will increase the energy produced by 30% to 50% depending on the season and location. The solar panels in the large arrays would cost in the thousands of dollars, so the addition of a solar tracker is very cost effective. Another benefit is the space saved rather than adding extra panels.

This system develops an automatic tracking system which will keep the solar panels aligned with the sun in order to maximize efficiency.

We Conclude with the ADVANTAGES of the TRACKER MODULE SYSTEM:

1. Uses SIMPLE, INEXPENSIVE, EASY TO GET 555 timers and LDRs.
2. The whole System draws only 25 Microamperes of Current when the Motors are not rotating.(555 timer's off-state current req. is very less).BATTERY POWER IS SAVED.
3. The TRACKER not only follows SUN from EAST to WEST and back to EAST in a cyclic manner (Horizontal Motor Module),but also tracks the Angular Movement of the SUN with respect to its ZENITH ANGLE to the Horizon(Vertical Motor Module and EYE).This is a VERSATILE quality for which the TRACKER could easily be used in conjunction with Solar Panels to derive maximum Solar Energy. Fast Motor Response (600 steps/sec.), no FALSE TRIGGERING, a Very ACCURATE System, it requires no Programming Devices (MICROPROCESSORS or MICROCONTROLLERS), so is NOT COMPLICATED.

XVII. CHALLENGES AHEAD AND FUTURE ENHANCEMENTS

□ Repairs and maintenance:-If the solar-tracked system breaks down when the solar panels are at an extreme angle,

the loss of production until the system is again functional can be substantial.

- Lifetime:-5-10year warranty
- Damage in a storm – a solar-tracked system is more likely to be damaged in a storm, depending on the angles of the solar panels at the time of the storm.
- The computer and System Control Unit would have a wireless communication with the mechanical structure of solar panel.
- More sensitive sensors would be used.

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